LRFD

Section 3.52

New: January 2005

CLICK HERE TO Index

Continuous Concrete Slabs - Section 3.52

3.52.1 General

This section illustrates the general design procedure for Continuous Concrete Slab Bridge using AASHTO LRFD Bridge Design Specifications.

1.1 Material Properties

Concrete:

LRFD Table 3.5.1.1 Unit weight of reinforced concrete, γ_c = 0.150 kcf

Continuous concrete slab

Class B-2 f'_c =4.0 ksi

n = 8

Intermediate bent columns, end bents (below construction joint at bottom of slab) in continuous concrete slab bridges

Class B-1 f'_c =4.0 ksi

n = 8

Class B, Open bent, footing f'_c = 3.0 ksi

n = 10

LRFD 5.4.2.4 Concrete modulus of elasticity, $E_c = 33000\ w_c^{1.5}\sqrt{f'_c}$

Where:

w_c = Unit weight of non-reinforced concrete = 0.145 kcf

LRFD 5.4.2.6 Modulus of rupture:

For minimum reinforcement, $f_r = 0.37\ \sqrt{f'_c}$

For deflection, camber and distribution reinforcement $f_r = 0.24\ \sqrt{f'_c}$

Reinforcing steel:

Minimum yield strength, f_y = 60.0 ksi

Steel modulus of elasticity E_s = 29000 ksi

LRFD Table 3.5.1.1 Unit weight of future wearing surface, γ_{fws} = 140 lb/ft^3

2.1 Limit States and Load Factors

In general, each component shall satisfy the following equation:

LRFD 1.3.2.1

$$Q = \sum \eta_i \gamma_i Q_i \leq \phi R_n = R_r$$

Where:

Q = Total factored force effect

Q_i = Force effect

η_i = Load modifier

γ_i = Load factor

ϕ = Resistance factor

R_n = Nominal resistance

R_r = Factored resistance

LRFD 9.5

Limit States

The following limit states shall be considered for slab and edge beam design:

STRENGTH – I
SERVICE – I
FATIGUE
EXTREME EVENT – II

Resistance factors

LRFD 5.5.4.2.1

For *STRENGTH* limit state,

Flexure and tension of reinforced concrete, $\phi = 0.90$

Shear and torsion, $\phi = 0.90$

LRFD 1.3.2.1

For all other limit states, $\phi = 1.00$

LRFD 1.3.2.1

Load Modifiers

For loads for which a maximum value of load factor is appropriate:

$$\eta = (\eta_I \eta_R \eta_D) \geq 0.95$$

For loads for which a minimum value of load factor is appropriate:

$$\eta = 1 / (\eta_I \eta_R \eta_D) \leq 1.0$$

Where:

LRFD 1.3.3 η_D = Factor relating to ductility

LRFD 1.3.4 η_R = Factor relating to redundancy

LRFD 1.3.5 η_I = Factor relating to operational importance

Load modifiers

	STRENGTH (slab overhang)	*STRENGTH* (slab interior)	All other Limit States
Ductility, η_D	1.0	1.0	1.0
Redundancy, η_R	1.0	1.0	1.0
Operational importance, η_I	1.0	1.0	1.0
$\eta = (\eta_I\ \eta_R\ \eta_D)$	1.0	1.0	1.0
$\eta = 1 / (\eta_I\ \eta_R\ \eta_D)$	1.0	1.0	1.0

2.2 Loads

Permanent (Dead) Loads

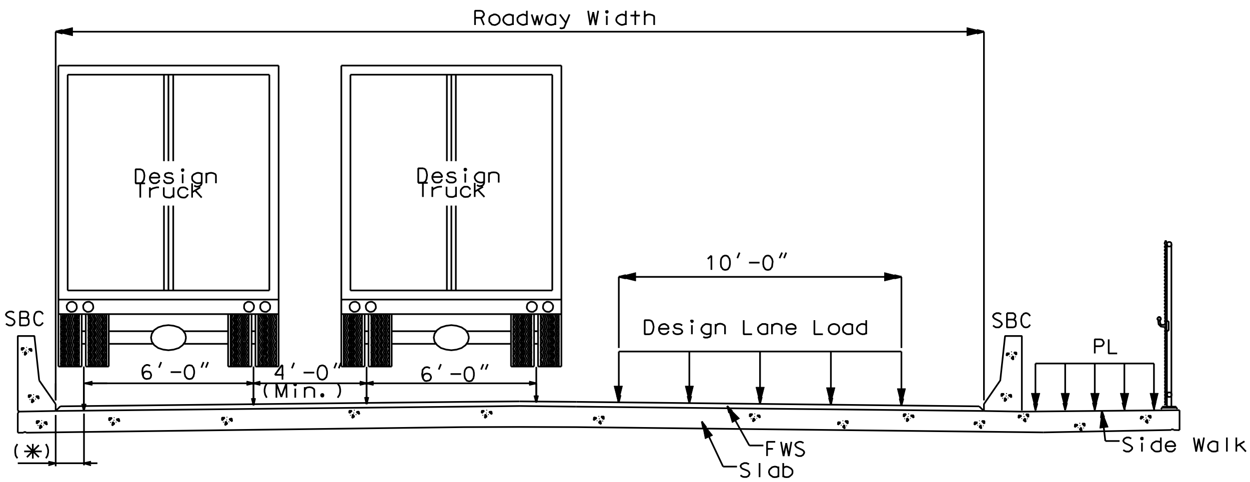
LRFD Table 3.5.1-1

Permanent loads include the following:

Slab weight

Future Wearing Surface (DW), FWS
A 3" thick future wearing surface (35psf) shall be considered on the roadway.

Safety Barrier Curb (DC), SBC
Assume the weight of the SBC acts at the centroid of the SBC.



✱ 12" for slab design (LRFD (3.6.1.3.1),
2'-0" for other design

Application of Live Load to Slab

Gravity Live Loads

Gravity live loads include vehicular, dynamic load allowance, and pedestrian loads.

LRFD 3.6.1.2

Vehicular
The design vehicular live load HL-93 shall be used. It consists of either the design truck or a combination of design truck and design lane load.

LRFD 3.6.1.3.3

For slab design, where the primary strips are longitudinal, the force effects shall be determined on the following basis:

- The longitudinal strips shall be designed for all loads specified in AASHTO Article 3.6.1.3.3 including lane load.

LRFD 3.6.1.2.4

- For the purpose of slab design, the lane load consists of a load equal to 0.640 klf uniformly distributed over 10 feet in the transverse direction.

LRFD 3.6.2.1

Dynamic Load Allowance
The dynamic load allowance replaces the effect of impact used in AASHTO Standard Specifications. It accounts for wheel load impact from moving vehicles. For slabs, the static effect of the vehicle live load shall be increased by the percentage specified in Table 1.

LRFD Table 3.6.2.1-1

Dynamic Load Allowance, *IM*

Slab Component	*IM*
Deck Joints – All Limit States	0.75
All Other Limit States	0.33

The factor to be applied to the static load shall be taken as:

$$(1 + IM)$$

The dynamic load allowance is not to be applied to pedestrian or design lane loads.

LRFD 3.6.1.1.2-1

Multiple Presence Factor, m:
The multiple presence factor accounts for the probability for multiple trucks passing over a multilane bridge simultaneously.

m = 1.20 for 1 Loaded Lane
1.00 for 2 Loaded Lanes
0.85 for 3 Loaded Lanes
0.65 for more than 3 Loaded Lanes

Pedestrian

LRFD 3.6.1.6

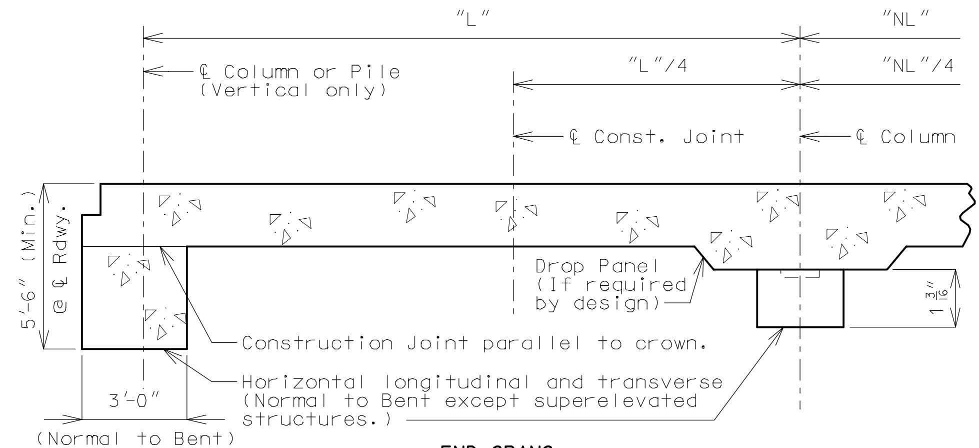
Pedestrian live load on sidewalks greater than 2 ft wide shall be:

PL = 0.075 ksf

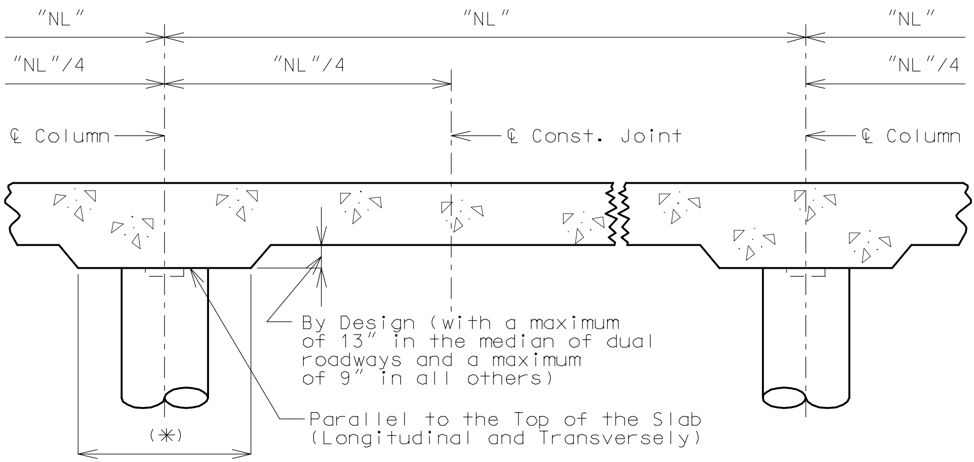
This does not include bridges designed exclusively for pedestrians or bicycles.

For Additional Design Information, see LRFD 5.14.4.2

SLAB LONGITUDINAL SECTIONS - SOLID SLABS



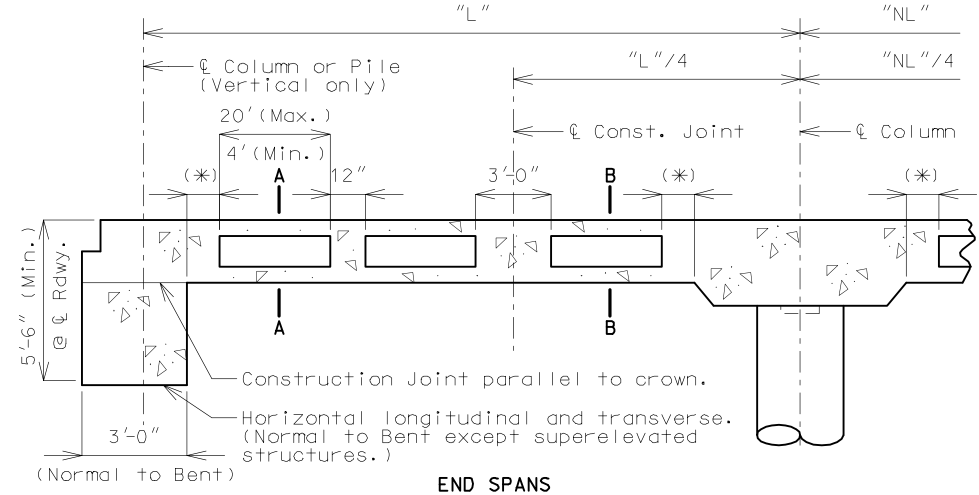
END SPANS



INTERMEDIATE SPANS

Note:
All longitudinal dimensions shown are horizontal.

SLAB LONGITUDINAL SECTIONS - CAST-IN-PLACE VOIDED SLAB



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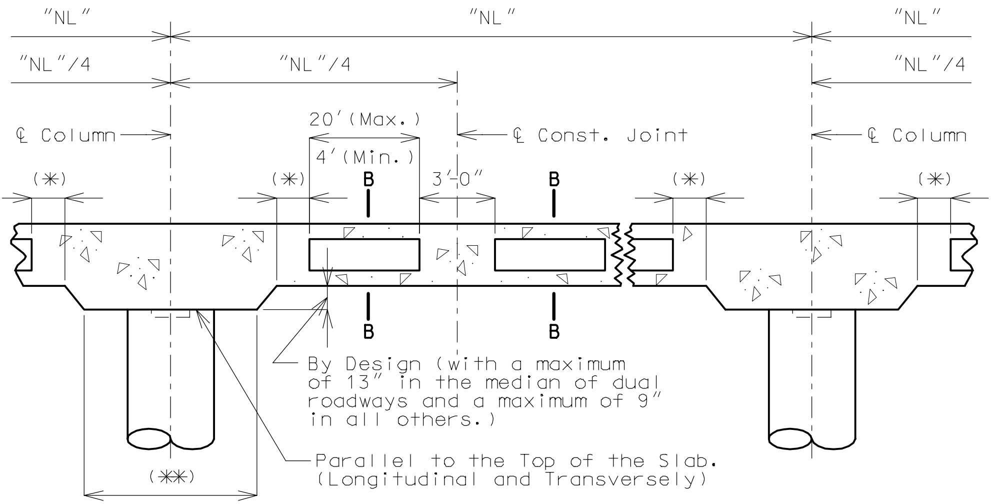


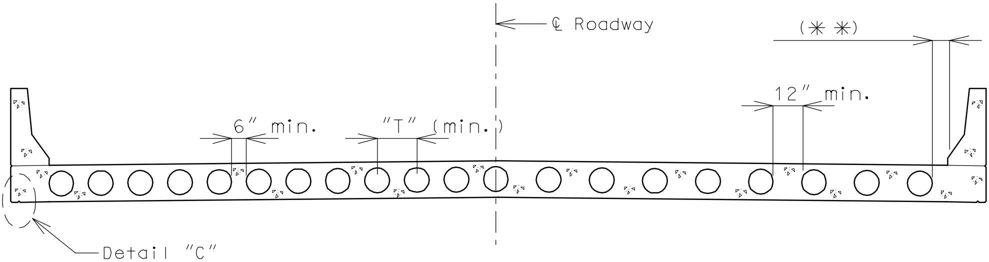
INTERMEDIATE SPANS

(✳) 3'-0" or greater than or equal to 5% of span length.

(✳✳) By Design (6" increments measured normal to the centerline of bent) (The minimum is equal to the column diameter + 2'-6")

Note:
All longitudinal dimensions shown are horizontal (Bridges on grades and vertical curves, included).
For sections A-A and B-B see sheet 3.2-2 this Manual Section.

SLAB CROSS SECTION

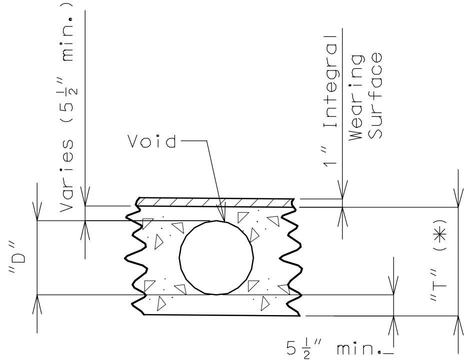


HALF SECTION A-A
CENTER OF SPAN

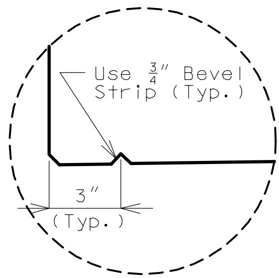
HALF SECTION B-B
NEAR INTERMEDIATE BENT

Sonovoids are produced in half sizes 2″ to 18″. D = 4″ to 36″

T=19″ (Min. preferred. Consult Structural Project Manager prior to the use of a thinner slab.)



PART SECTION THRU VOID



DETAIL "C"

Notes:

(✻) Increase the Dimension "T" by ½″ for #14 bars placed in the top or bottom of the slab.
Increase the Dimension "T" by 1″ for #14 bars placed in the top and bottom of the slab.
("T" and "D" are based on 3″ clearance which includes the integral wearing surface to the top of the longitudinal bar.)

(✻✻) For Roadways with slab drains, use 10″ minimum. For Roadways that require additional reinforcement for resisting moment of the edge beam 20″ minimum. Check for adequate space for accomodation for development of Safety Barrier reinforcement.